INTERNET2®

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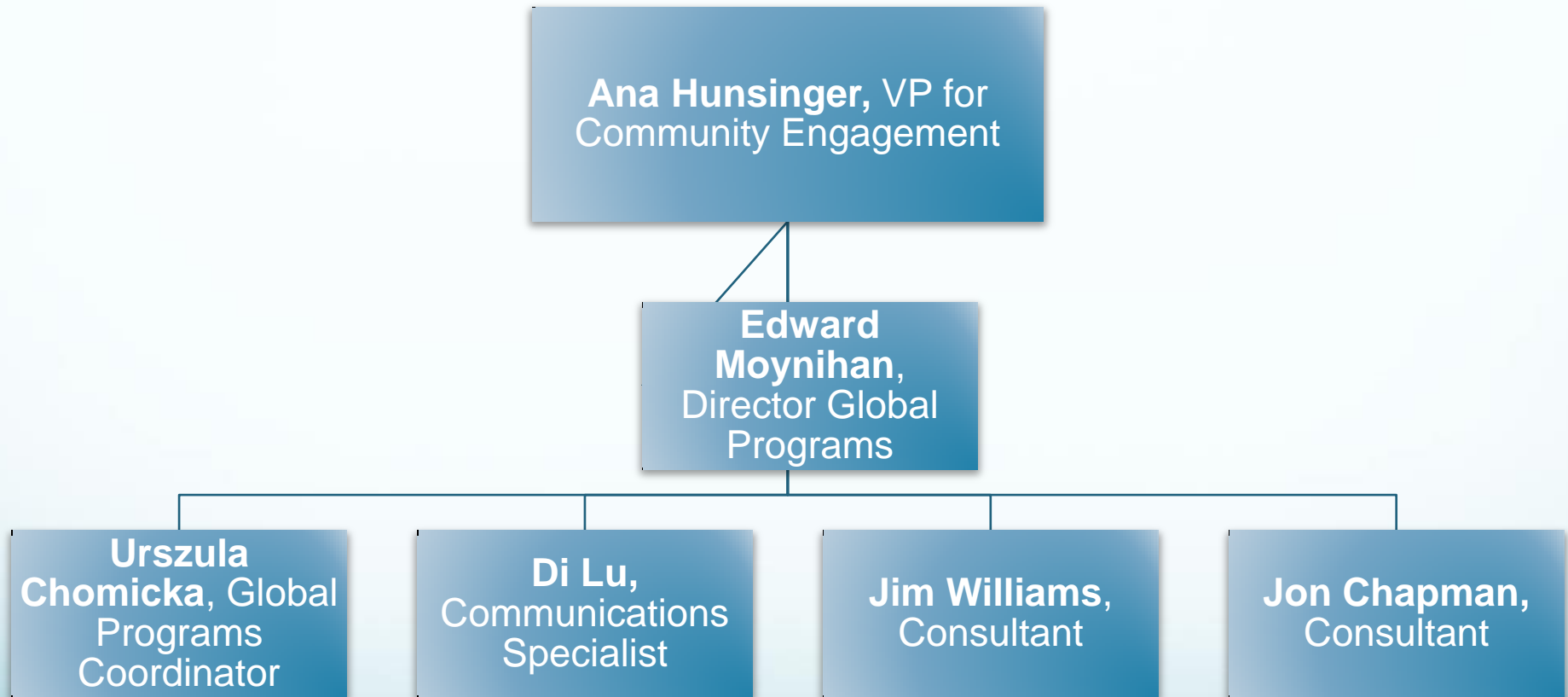**URSZULA CHOMICKA**

FEB. 16 2016

Internet2's Global Programs:
International Connectivity

Update for JET meeting

Global Programs Team

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Di Lu, Communications Specialist

Jim Williams, Consultant

Jon Chapman, Consultant

INTERNATIONAL PARTNERSHIPS

AMERICAS
CANARIE (Canada)
CEDIA (Ecuador)
CNTI (Venezuela)
CR2Net (Costa Rica)
CUDI (Mexico)
INNOVA|RED (Argentina)
REUNA (Chile)
RNP [FAPESP] (Brazil)
SENACYT (Panama)

MULTI-NATIONAL
AAU (Africa)
APAN (Asia - Pacific)
CKLN (Caribbean)
CLARA (Latin America and Caribbean)
GEANT (Europe)
NORDUnet (Nordic Countries)
TEIN*CC (Asia-Pacific)
UbuntuNet Alliance (Africa)
University of the West Indies (Caribbean)
WACREN (West and Central Africa)

EUROPE
ARNES (Slovenia)
BELNET (Belgium)
CARNET (Croatia)
CESnet (Czech Republic)
DFN (Germany)
FCCN (Portugal)
GARR (Italy)
RENATER (France)
GRNET (Greece)
HEAnet (Ireland)
HUNGARNET (Hungary)
JISC, JANET (United Kingdom)
PSNC, PIONIER (Poland)
RedIRIS (Spain)
RESTENA (Luxemburg)
RIPN (Russia)
SANET (Slovakia)
SURF (Netherlands)
SWITCH (Switzerland)

ASIA and PACIFIC RIM
AARNet (Australia)
ANF, KREOnet (Korea)
NKN (India)
CERNET, CSTNET (China)
JAIRC (Japan)
JUCC (HongKong)
MYREN, MDeC (Malaysia)
NECTEC, UniNet (Thailand)
NKN (India)
NREN (Nepal)
PERN (Pakistan)
REANNZ (New Zealand)
SingAREN (Singapore)
TWAREN (Taiwan)
VinaREN (Vietnam)

MIDDLE EAST and GULF STATES
ANKABUT (UAE)
Israel-IUCC (Israel)
MCIT [EUN, ENSTINET] (Egypt)
Qatar Foundation (Qatar)
KACST (Saudi Arabia)

AFRICA
TENET (South Africa)
TERNET (Tanzania)
NUC (Nigeria)
SANREN (South Africa)

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Current Networks Reachable

AFRICA
Algeria (ARN)
Egypt (EUN / ENSTINET)
Kenya (KENET)
Morocco (MARWAN)
South Africa (TENET)
Tanzania (TERNET)
Tunisia (CCK)
Uganda (RENU)

AMERICAS
Argentina (INNOVA|RED)
Brazil (RNP2/ANSP)
Canada (CAnet 4)
Chile (REUNA)
Colombia (RENATA)
Costa Rica (CR2Net)
Ecuador (CEDIA)
El Salvador (RAICES)
Guatemala (RAGIE)
Mexico (CUDI)
Panama (RedCyT)
Peru (RAAP)
Trinidad (UWI)
Uruguay (RAU2)
Venezuela (Reacciun2)

ASIA and PACIFIC
Australia (AARNet)
Bhutan (BdREN)
Cambodia (CamREN)
China (CERNET2, CSTNET, NSFCNET)
Hong Kong (HARNET)
India (ERNET)
Indonesia (ITB)
Japan (SINET3, WIDE, JGN2)
Korea (KOREN, KREONET2)
Laos (LERNET)
Malaysia (MYREN)
Nepal (NREN)
New Zealand (KAREN)
Pakistan (PERN)
Philippines (PREGINET)
Singapore (SingAREN)
Sri Lanka (LEARN)
Taiwan (TANet2, ASnet)
Thailand (UniNet, ThaiSARN3)
Vietnam (VinaREN)

CENTRAL and SOUTHWEST ASIA
Armenia (ASNET-AM)
Azerbaijan (AzRENA)
Georgia (GRENA)
Kyrgyz Republic (AKNET)
Tajikistan (TARENA)
Turkey (ULAKBIM)
Turkmenistan (TuRENA)

EUROPE
Albania (ASA / INIMA)
Andorra (Univ. of Andorra)
Austria (ACOnet)
Belarus (BASNET, UNIBEL)
Belgium (BELNET)
Bosnia-Herzegovina (BIHARNET)
Bulgaria (ISTF)
Croatia (CARNET)
Cyprus (CyNET)
Czech Republic (CESnet)
Denmark (Forskningsnettet)
Estonia (EENet)
Finland (Funet)
France (RENATER)
Germany (X-WiN)
Greece (GRNET)
Hungary (NIIF/HUNGARNET)
Iceland (RHnet)
Ireland (HEAnet)
Italy (GARR)
Latvia (LATNET)
Lithuania (LITNET)
Luxembourg (RESTENA)
Macedonia (MARNet)
Malta (UofM/RicerkaNet)
Moldova (RENAM)
Montenegro (MREN)
Netherlands (SURFnet)

EUROPE cont'd
Norway (UNINETT)
Poland (PIONIER)
Portugal (FCCN)
Romania (RoEduNet)
Russian Federation (RBnet, RUNNET)
Serbia (AMRES)
Slovakia (SANET)
Slovenia (ARNES)
Spain (redIRIS)
Sweden (SUNET)
Switzerland (SWITCH)
Ukraine (URAN)
United Kingdom (JANET)

MIDDLE EAST and GULF STATES
Israel (IUCC)
Jordan (JUNet)
Palestinian Territories (Birzeit Univ./Al-Quds Open Univ.)
Qatar (Qatar FN)
Syria (HIAST)
United Arab Emirates (ANKABUT)

MULTINATIONAL NETWORKS
APAN
GEANT2
NORDUnet
redCLARA
TEIN*CC
UbuntuNet
WACREN
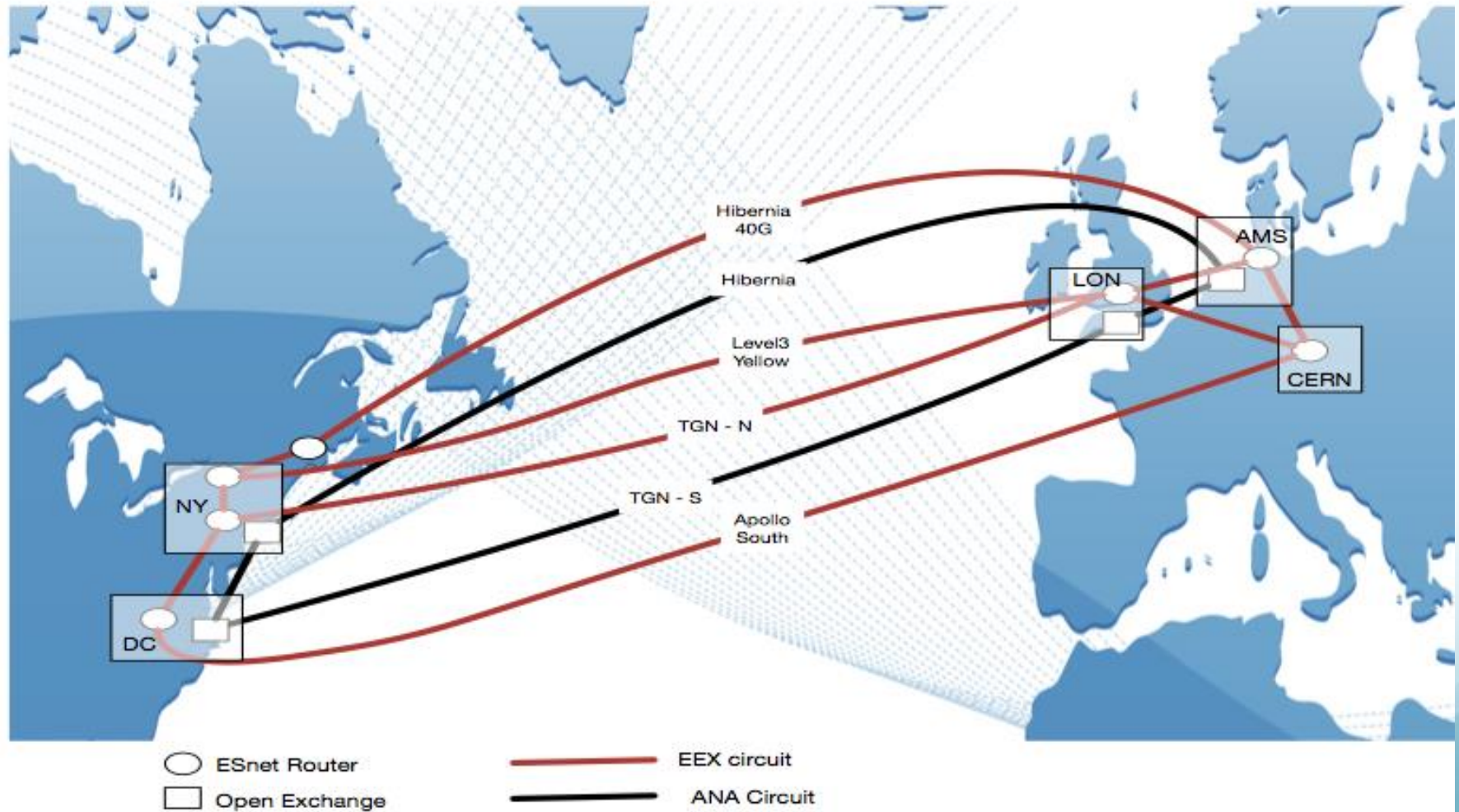
DRAFT – INTERNAL ONLY

Internet2 Investments

- Internet2 is making major investments:

  - ANA
  - Fujairah
  - Singapore.

Transatlantic

- ANA-200G production ring completed in Nov. 2014-redundant 100 Gbit/s ring between four open exchange points spanning the North Atlantic.

- Internet2, NORDUnet, CANARIE and SURFnet partnered on this project.

- Both ANA-200G and ESnet attained full production status at the end of 2014.

- Reciprocal back-up agreement of 340Gbit/second between ANA-200 and ESnet since April 2015

Fat Pipes: ANA-200G - production ready Q4 2014

Hibernia 40G
Hibernia
Level3 Yellow
TGN - N
TGN - S
Apollo South

AMS
LON
CERN
NY
DC

○ ESnet Router
□ Open Exchange
— EEX circuit
— ANA Circuit

Other Internet2 Investments

Middle East:

- AGE – OX (Arabian Global Education Open Exchange Point) in Fujairah

- Commitment to fund 10G connectivity to Singapore – NYU Abu Dhabi/Ankabut/Internet2 (currently 2.5G)

TransPacific:

- 100G Internet2/SingAREN partnership (Singapore to LA). Production 2016.

- 10G Internet2/CERNET partnership (Beijing/LA).

Singapore connections
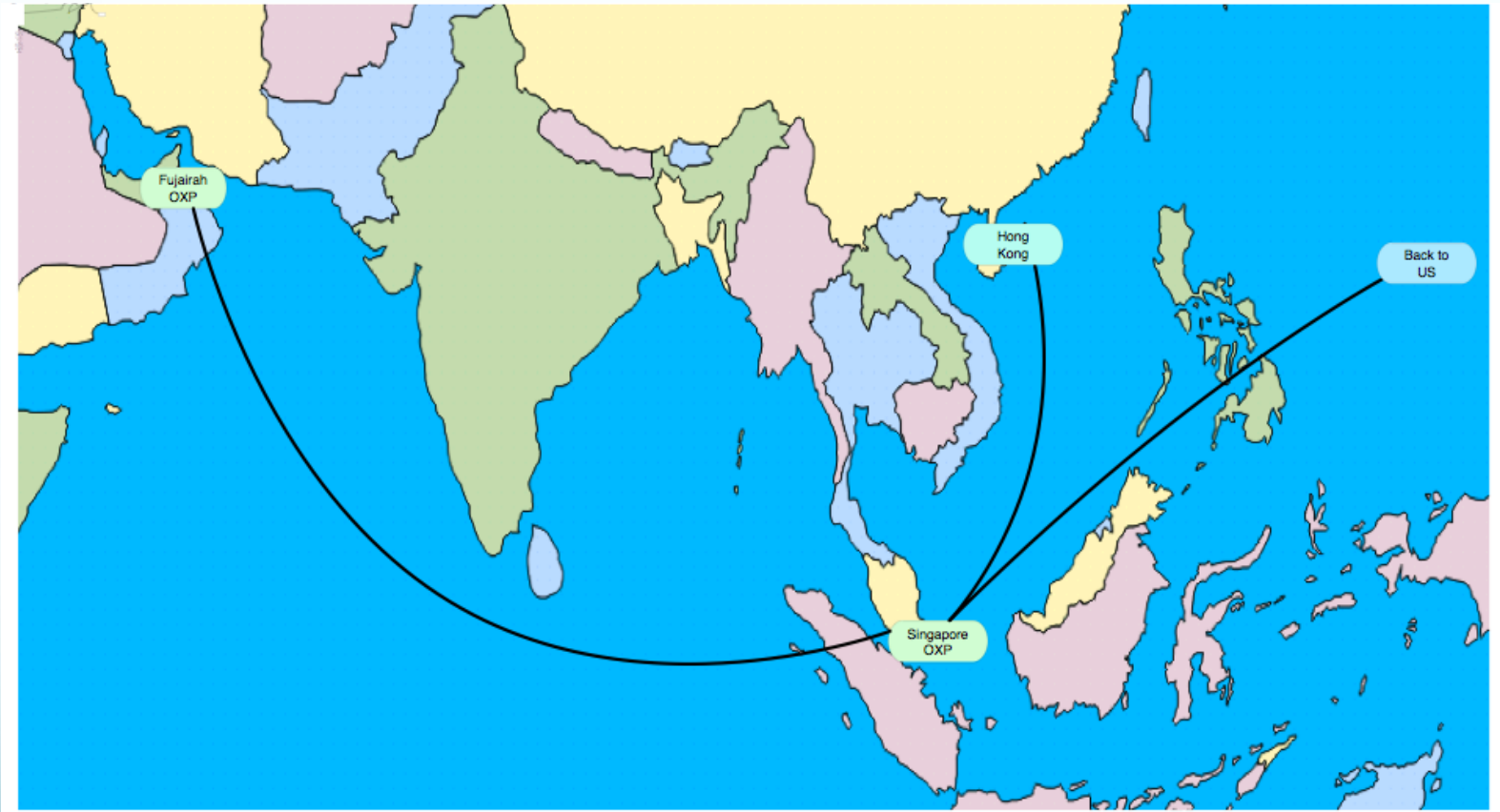
US-Mexico border connectivity upgrade

- Internet2 and CUDI are working together to upgrade cross-border connectivity at El Paso from 1 gb to 10 gb (expected March 2016)

New strategic investments will:

- Support the extension of Internet2 Innovation Platform into Mexico

- Enhance support of US/Mexico big data science collaborations

IRNC links

- Americas Lightpaths Express and Protect (AmLight ExP) project - grant to implement a hybrid network strategy that combines the use of optical spectrum (Express) and leased capacity (Protect).

- FIU and Georgia Tech - award for the collaborative AtlanticWave-SDX, a distributed experimental Software-Defined Exchange Point (SDX), supporting research, experimental deployments, prototyping and interoperability testing, on national and international scales.

- IU Global Research Network Operations Center, or GlobalNOC - $3.6 million award to manage the Network Operations Center for all IRNC infrastructure projects.

- The IU GlobalNOC won a $4.8 million networking grant to enable continued planning, operation, engineering support and management of TransPAC, the high-speed network that connects researchers in the US with their counterparts in Asia.

- IU, UH Mānoa and UC Davis - grant of $5 million for 5-year project called NetSage, an open privacy-aware network measurement analysis and visualization service that will monitor and visualize all the network traffic flowing over the NSF's R&E networks.

- Northwestern, UCSD and UIC - 5-year grant to develop an international Software Defined Networking Exchange (SDX) at the StarLight International/National Communications Exchange Facility in Chicago.

Europe

- GEANT Project, Dante and TERENA have merged to become GEANT, formed October 2014 and effective May 1, 2015.
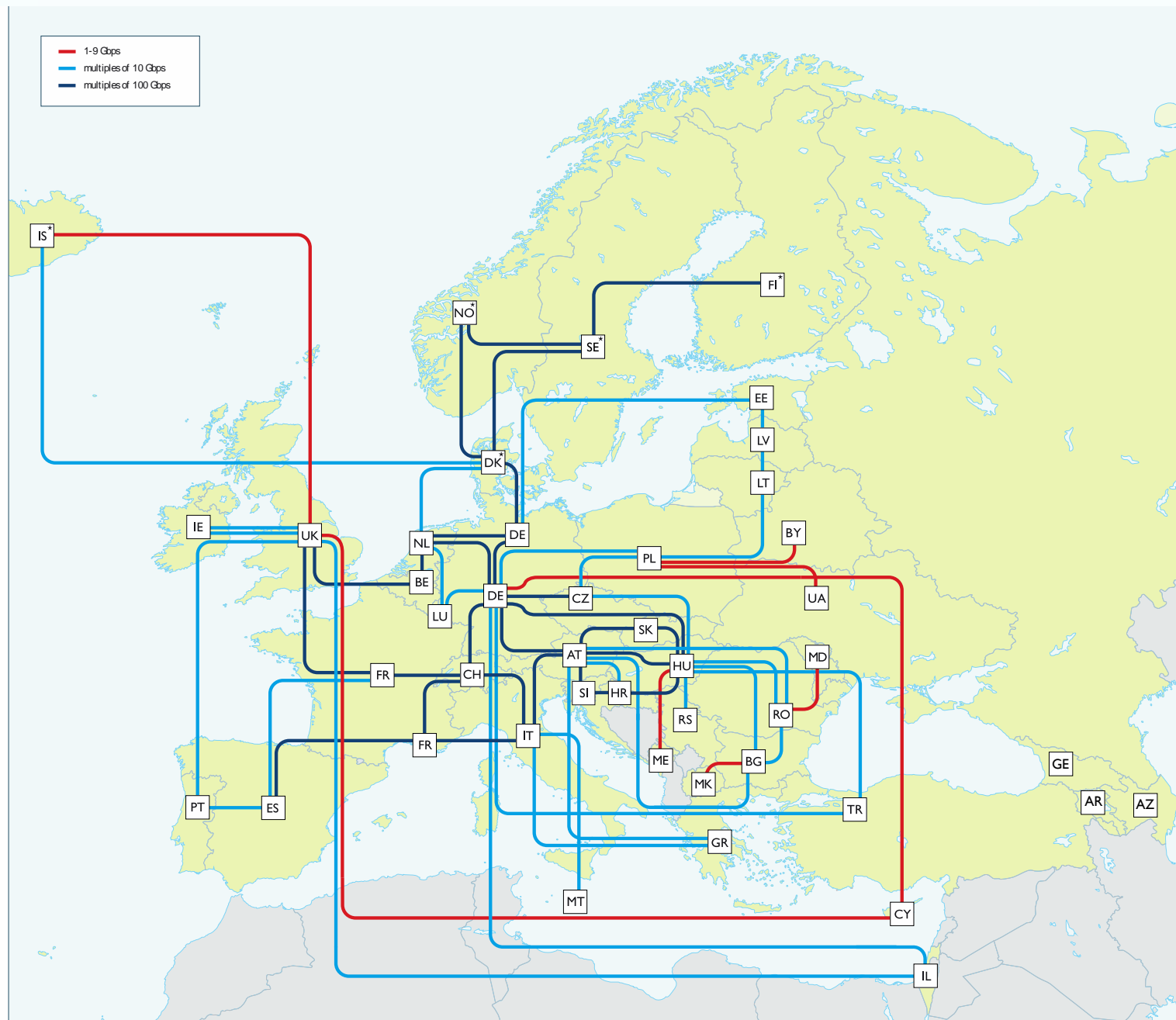
European network status

- 40 European countries connected

- Routers with 100Gbps capability, optical transmission platform designed to provide 500Gbps super-channels

- 27,114km of dark fibre, 100,000+ km of leased capacity (including transatlantic connections)

- 28 main sites covering European footprint

- New 10G circuit London-Beijing inaugurated Sept 2015 (operational since July), cost-share model

GÉANT and partner networks enabling user collaboration across the globe

September 2014
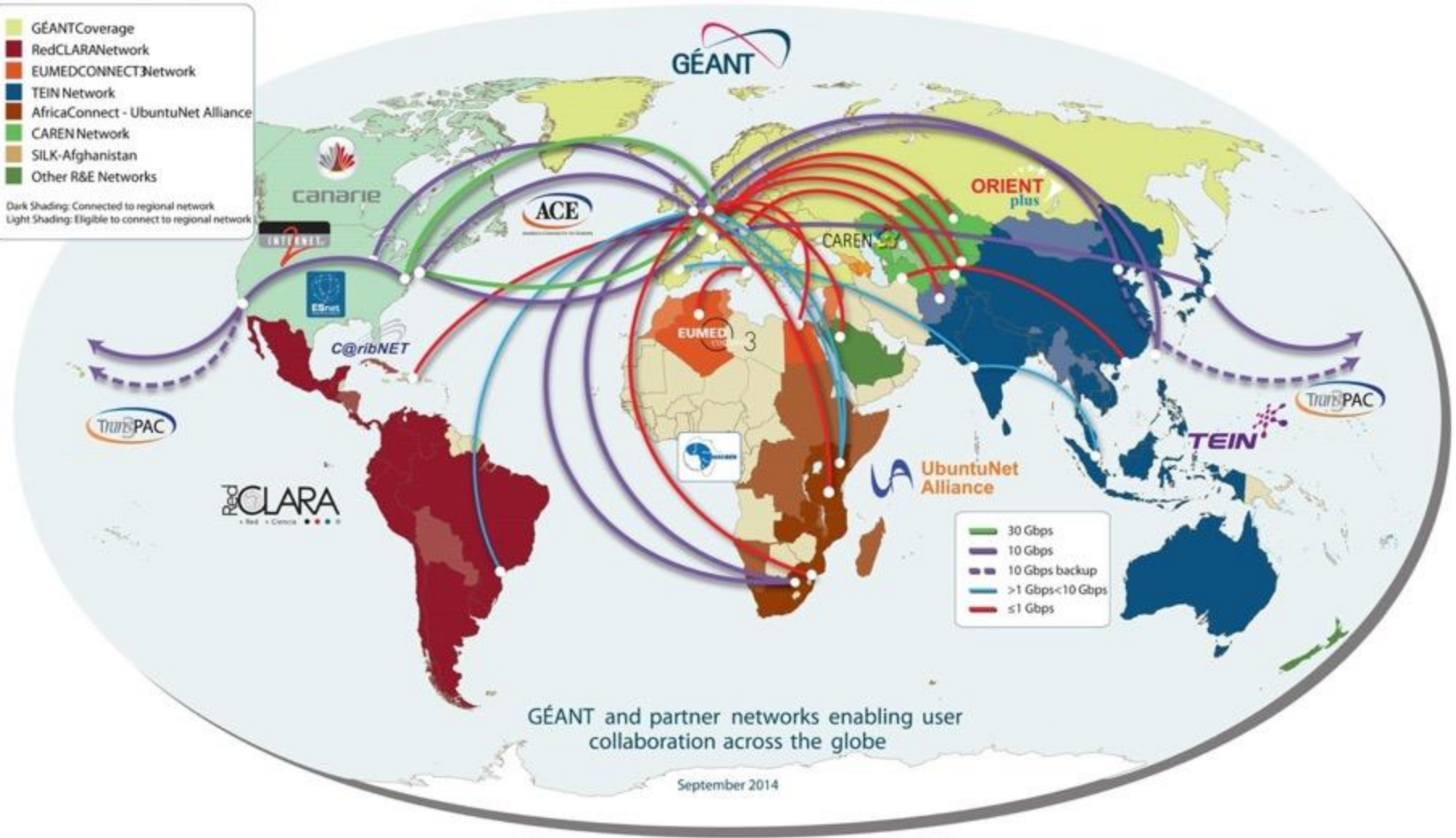
Asia connectivity

- TEIN*CC is an independent, Asia Pacific based network organization

- TEIN4 since 2012 (transferring responsibility from DANTE to TEIN*CC until 2016). European Commission is contributing 8M € for TEIN4.

- Interconnects universities and research centers in 18 countries: China, India, Indonesia, Japan, Korea, Malaysia, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Vietnam, Australia, Bangladesh, Cambodia, Laos and New Zealand.

- It also connects to GÉANT at 2.5Gbps from Madrid to Mumbai and at 10Gbps via the ORIENTplus Beijing-London link.
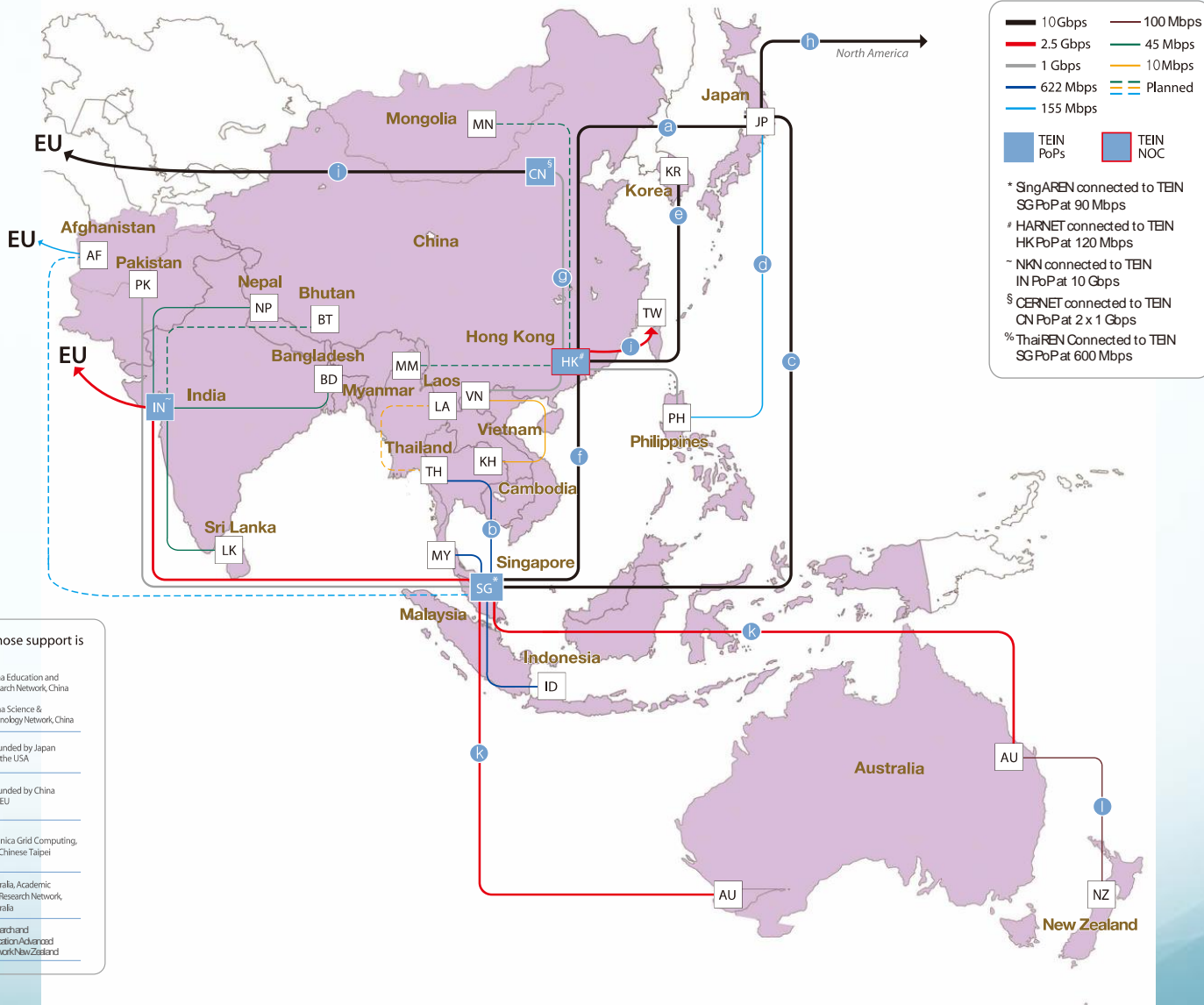
INTERNET 2

TEIN

Connecting
Asia and Europe's
Research and Education
Communities

www.tein.asia

Legend

- 10Gbps
- 2.5 Gbps
- 1 Gbps
- 622 Mbps
- 155 Mbps
- 100 Mbps
- 45 Mbps
- 10 Mbps
- Planned

TEIN PoPs
TEIN NOC

North America

* SingAREN connected to TEIN SG PoP at 90 Mbps
# HARNET connected to TEIN HK PoP at 120 Mbps
~ NKN connected to TEIN IN PoP at 10 Gbps
§ CERNET connected to TEIN CN PoP at 2 x 1 Gbps
% ThaiREN Connected to TEIN SG PoP at 600 Mbps

TEIN Project Partners

AF Afghanistan	ID Indonesia	NZ New Zealand
AU Australia	JP Japan	PK Pakistan
BD Bangladesh	KR Korea	PH Philippines
BT Bhutan	LA Laos	SG Singapore
KH Cambodia	MM Myanmar	LK Sri Lanka
CN China	MN Mogolia	TH Thailand
HK Hong Kong	MY Malaysia	TW Taiwan
IN India	NP Nepal	VN Vietnam

Map labels

Mongolia, China, Japan, Korea, Afghanistan, Pakistan, Nepal, Bhutan, Bangladesh, Myanmar, Laos, Vietnam, Hong Kong, Taiwan, Philippines, India, Sri Lanka, Thailand, Cambodia, Singapore, Malaysia, Indonesia, Australia, New Zealand
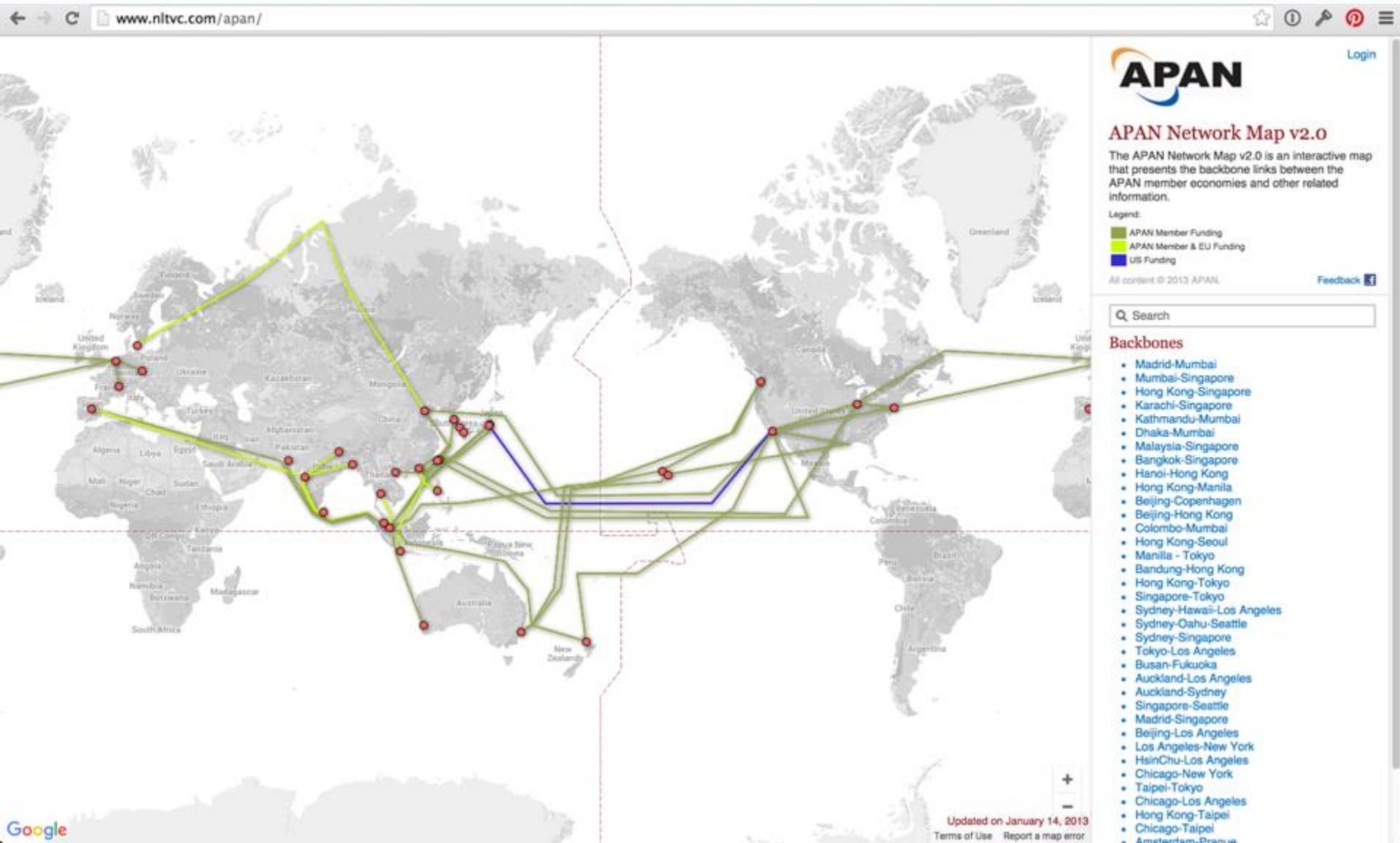
EU

The following links are fully financed by the link owners whose support is gratefully acknowledged.

a — NICT — National Institute of Information and Communications, Japan
b — NICT — National Institute of Information and Communications, Japan / Thailand Research and Education Network, Thailand
c — NII — National Institute of Informatics, Japan
d — MAFFIN — Ministry of Agriculture, Forestry and Fisheries Research Network, Japan
e — NIA — National Information Society Agency, South Korea
f — NIA
g — CERNET — China Education and Research Network, China / China Science & Technology Network, China
h — TransPAC — co-funded by Japan and the USA
i — ORIENT plus — co-funded by China and EU
j — ASGC — Academia Sinica Grid Computing, Republic of Chinese Taipei
k — aarnet — Australia, Academic and Research Network, Australia
l — REANNZ — Research and Education Advanced Network New Zealand

As of July 2015

TEIN CC
COOPERATION CENTER
www.teincc.org

TEIN is co-funded by the European Commission through the Directorate–General for Development and Cooperation–EuropeAid

This map has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of TEIN*CC and can under no circumstances be regarded as reflecting the position of the European Union.

APAN Network Map Version 2.0

Future TransPacific

- India: 10G – potential 3 10 G (Quarter 2, 2016)

- China: CERNET 10G (Beijing to LA)
  - New US peerings for CERNET and CSTNET

- Japan: SINET 100 G to US; WIDE 100G (TransPAC)

- Korea: KREONET 100G to Chicago

- Australia/Hawaii – upgrades to 100 G

MENA Update

- The North African project partners from EUMEDCONNECT are migrating into AfricaConnect2.

- A lot of difficulties stemming from the political instability, particularly of North Africa.

- 3 links currently in service:
  - Algeria – ARN - 622Mbps
  - Jordan -ASREN (JUNET) - 155Mbps (Nov. 2014)
  - Egypt -ENTSTINET - 622Mbps

ASREN

- Established in 2012

- 6 Shareholders:
    - Abu-Ghazaleh GmbH (Jordan)
    - JUNET (Jordan)
    - EUN (Egypt)
    - CNRST (Morocco)
    - SudREN (Sudan)
    - CCK (Tunis)

- Connected to the global R&E network via links to GEANT and Internet2
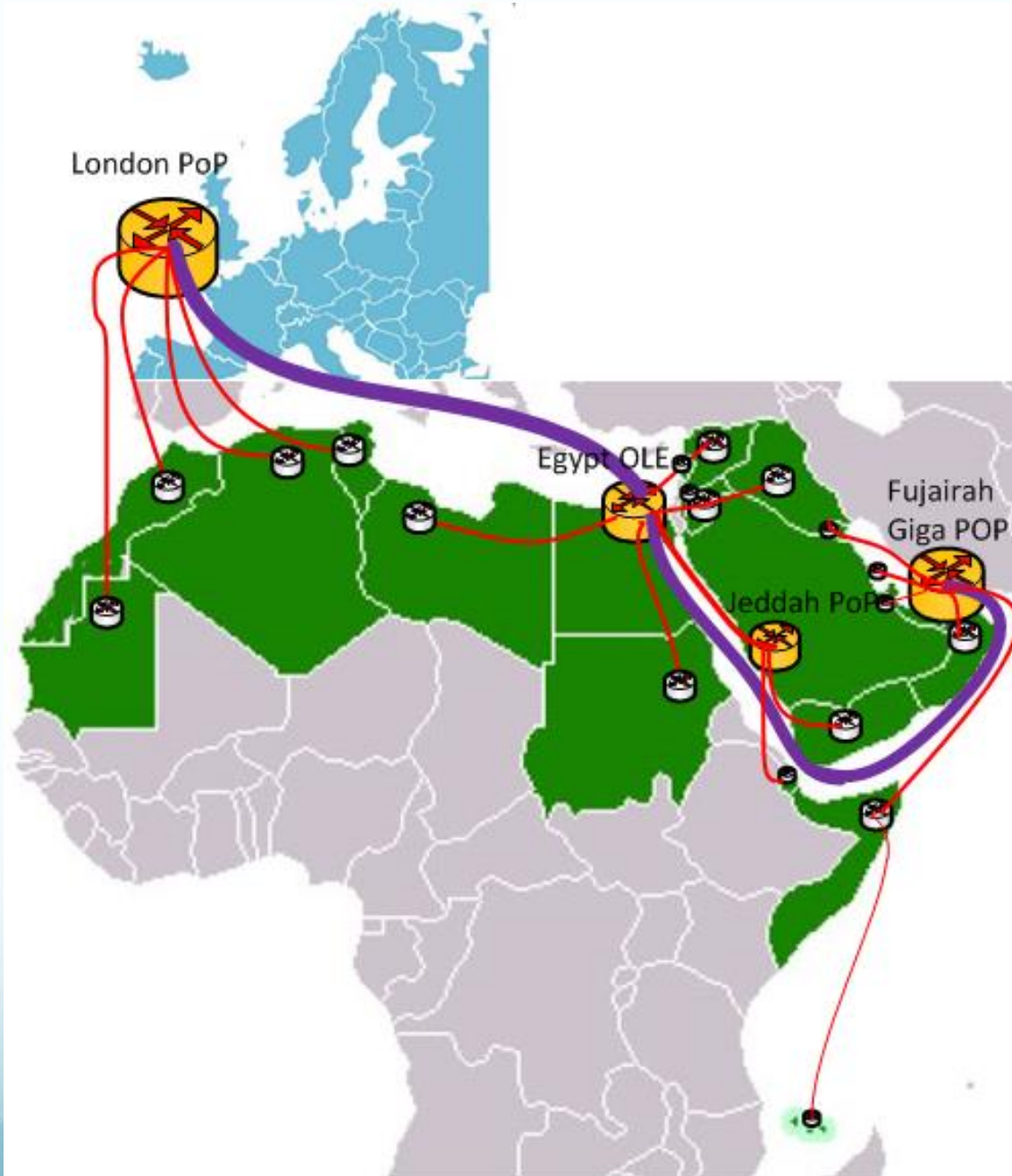
Africa connectivity

- AfricaConnect ended in 2015 (4-year project). 80% EU funding, 20% local.

- **July 2014:** commissioning of the UbuntuNet network (interlinking Eastern and Southern Africa, providing connectivity to Europe)

- AfricaConnect2 awarded and announced July 2015 (3.5-year project)

AfricaConnect2 – future

- 3 geographical clusters:

- Cluster 1: Southern and Eastern Africa (contracted between the EC and the UbuntuNet Alliance)

- Cluster 2: Western and Central Africa (coordinated by GÉANT in conjunction with WACREN)

- Cluster 3: North Africa (coordinated by GÉANT in conjunction with ASREN).

UA Updates

- **July 2014: commissioning of the UbuntuNet network (Eastern and Southern Africa)**

- **Block A**: February 2014 – established PoPs in Mtunzini, Maputo, Dar es Salaam, Nairobi, Kampala and Kigali, and upgraded the UA PoP in London.

- Procured cross-border links and transcontinental link between Nairobi and UA PoP in Amsterdam.

- Serves 6 NRENs: TENET (South Africa), MoRENet (Mozambique), TERNET (Tanzania), KENET (Kenya), RENU (Uganda) and RwEdNet (Rwanda).

- equipment procurement, installation of high capacity cross-border links connecting the NRENs: Eb@le (Democratic Republic of Congo), MAREN (Malawi) and ZAMREN (Zambia).

- Link between Dar es Salaam in Tanzania and Lusaka in Zambia completed May 2014

- Links from Lusaka to Blantyre in Malawi, and from Cape Town to Moanda in DRC (future)

- Result: connectivity costs have dropped from a regional average of $4000 per megabit per second per month to $135per megabit per second per month

KEY

━━━ Ubuntunet Alliance links

━━━ LINKS PROCURED FROM PARTNER NREN

╌╌╌ LINKS UNDER IMPLEMENTION

WACREN - Update

- 8 formally established NRENs, 4 in development

- Capacity-building:

    -2 workshops: Open source tools for server virtualisation; clustering and management, and network monitoring and measurement.

    -Training needs assessment

- Involved in 3 EU Projects (HORIZON2020)+ AfricaConnect2

- MOU signed with Internet2 – call for collaboration
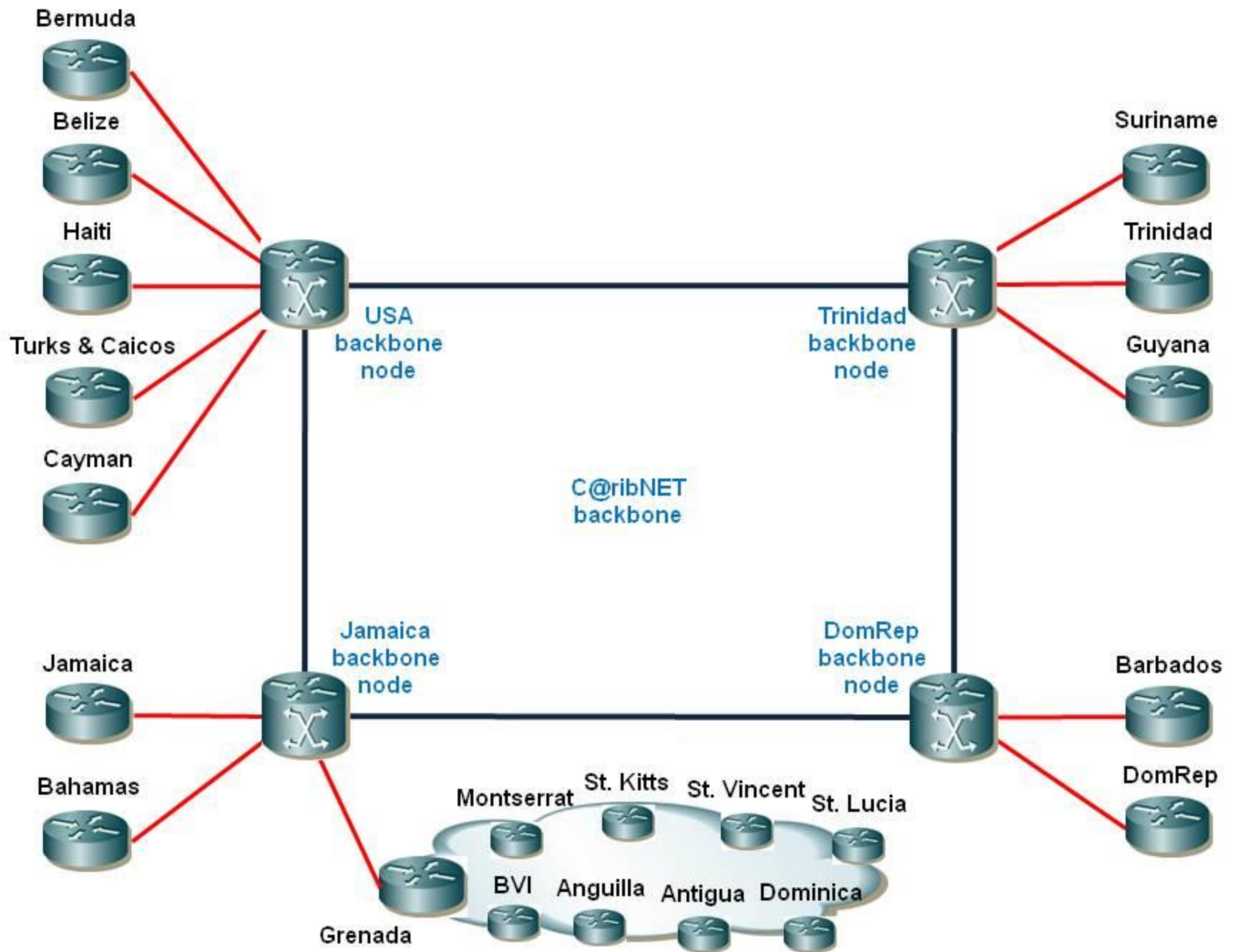
West and Central Africa
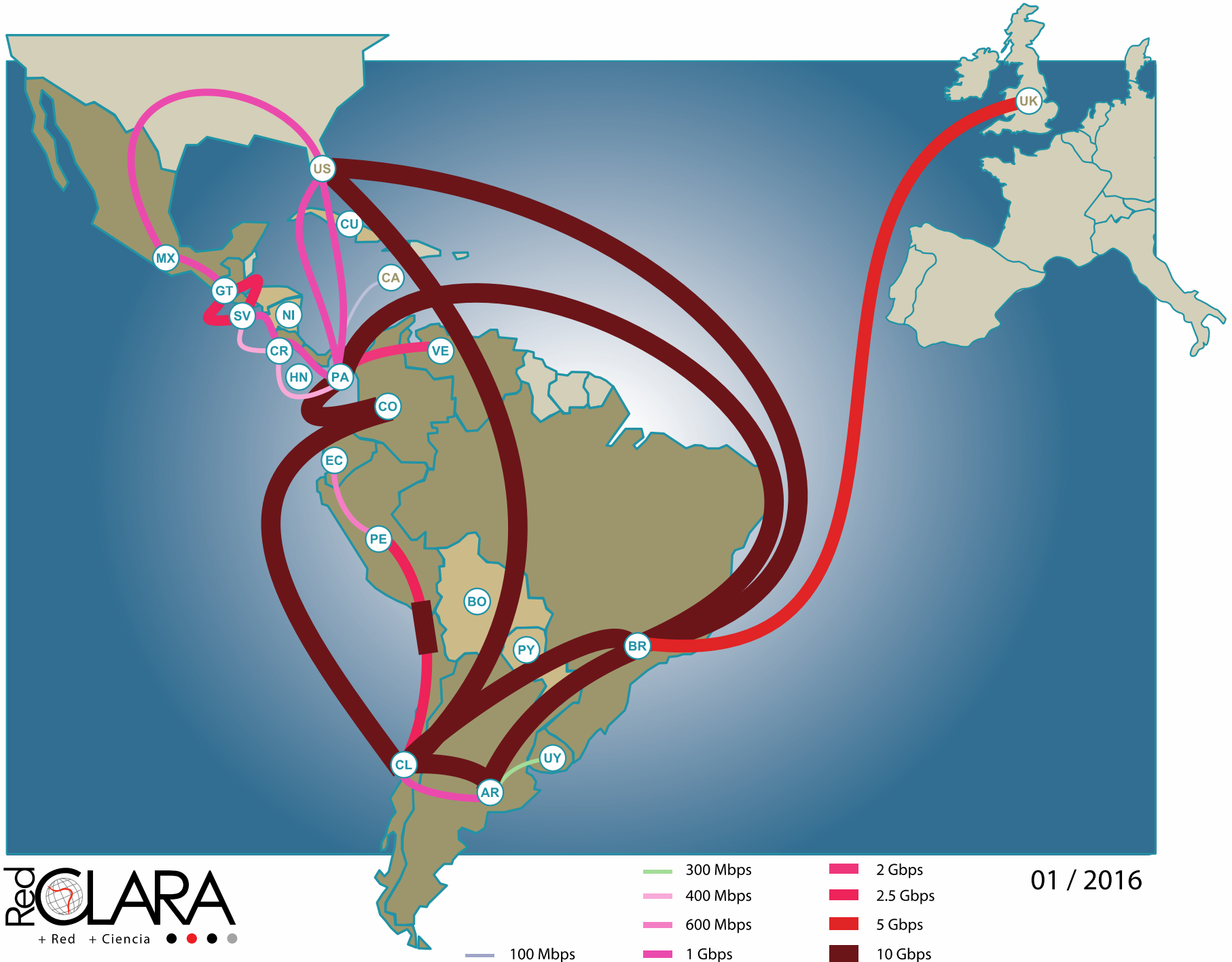
C@ribnet

- 2013: Caribbean institutions connected.

- Launch of C@ribNET

- C@ribNET Portal developed

- Network services introduced

- More institutions have been connected, technical representatives trained, the e-infrastructure for the national networks in most CARICOM countries exists, and C@ribNET has been demonstrated to be functional and operational with scalable infrastructure.

- Partnership with Internet2

INTERNET 2

GÉANT

North Atlantic Ocean

Gulf of Mexico

AMPATH

Caribbean Sea

RedCLARA

North Pacific Ocean

Caribbean Knowledge and Learning Network

Questions? Comments?

uchomicka@internet2.edu